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记山东沂南上新世熊属一新种

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关键词 山东沂南 上新世 *Ursus*

内 容 提 要

本文记述了产自山东沂南一洞穴堆积中的熊类化石一新种：*Ursus yinanensis*。这种熊具有个体较小，前臼齿数目全，下裂齿的下后尖之前尚未出现附尖等原始性特征，它与欧洲早上新世的 *Ursus boeckhi* 在进化程度上比较接近但更显进步。这是在中国首次发现的中上新世 *Ursus* 的可靠记录，它的发现对于探讨欧亚大陆上真正熊类的演化及地理分布等问题具有重要意义。

在熊科动物的众多成员中，*Ursus* 是少数残留至今的杂食性适应类群之一，关于它的起源演化的研究历来为学术界所关注。一般认为它最早出现于欧洲早上新世，是由 *Ursavus*（祖熊）中的一支演化而来。虽然 *Ursus* 在熊科中起源最晚，但它的演化速度快，分布广，是欧亚大陆早上新世到更新世陆相地层中最常见的动物化石之一，对于生物地层对比及年代确定起着相当重要的作用。我国上新世的 *Ursus* 只有零星的材料报道，这一类大量出现并广泛分布的格局则是发生在进入更新世以后，而且一出现就已经是相当进步或特化的类型，一直延续至今。

本文记述的熊化石产于山东临沂地区沂南县马牧池乡的双泉西山洞穴堆积（中国科学院古脊椎动物与古人类研究所野外化石地点编号：88002）。洞穴围岩由奥陶纪的白云质灰岩构成，堆积物基本为一套混杂堆积，以浅棕红色含灰岩角砾的粘土岩为主，其间充填有丰富的碳酸钙结晶，胶结坚硬。堆积物厚度约 4.2m。其中发现有较为丰富的化石，多保存完整，初步计有鸟类、爬行类、食肉目、啮齿目和翼手目等。本文仅先就其中的熊类化石作一详细研究。

一、化 石 描 述

熊科 Ursidae Gray, 1825

熊属 *Ursus* Linnaeus, 1758

沂南熊 *Ursus* (*Protarctos*) *yinanensis* sp. nov

（图 1—3； 图版 I,II）

正模 属同一成年个体的头骨连有一对下颌（中国科学院古脊椎动物与古人类研究所标本编号 V10320）。头骨受侧压变扁，骨片多错位叠复，左侧枕区、耳区及颧弓部分缺

损。所有上门齿及 P[1)]1—3 都只保留齿槽孔。左下颌 i1—3 及 m3 缺失；右下颌犬齿齿冠断失，i1—3 缺失，m1 下原尖破损，下颌角突末端残缺。

正模产地　山东沂南马牧池乡双泉西山。

归入标本　单个右 m1(V10321)，下前尖缺失。产地同上。

地层及时代　洞穴堆积中的浅棕红色含灰岩角砾粘土岩层。时代可能为中上新世(大体相当于欧洲的 MN16a)。

词源　种名取自化石产地沂南县的汉语拼音。

特征　头骨吻部短小，鼓室扁平，下颌联合部外缘与水平支长轴夹角大于45°。上、下犬齿侧向直径远小于前后向直径。前臼齿数目全。裂齿（P4/ml）裂叶构造退化。P4 缩小而 M1 和 M2 明显增大伸长。M1 无前、后附尖。M2 跟座占齿长的 1/2，冠面上有较发育的褶皱。m1 三角座与跟座高度一致，下原尖偏向牙齿外缘，下后尖之前没有附尖。m2、m3 相对 m1 短小。

描述　头骨(图 1；图 2,A；图版 I)：根据头骨上骨缝未完全愈合，有较发达的矢状脊，颊齿磨蚀程度中等偏深判断，可能为一刚进入成年的个体。头骨较小，狭长，吻部短窄，头长近 280mm，额骨眶上突连线之前的头骨长度约 120mm，与此连线之后头长的比例为 3/4（即面颅部比脑颅所占的比较小）。门齿区前缘呈抛物线形。鼻骨长 62mm，顶面中央略凹陷，末端的位置与眶窝中间相当。顶视，额骨前端变细，插入鼻骨与上颌骨之间，额颌缝末端位于眶窝前缘或额骨眶上突的中间偏后，由额骨眶上突发出的两条显著的人字形额脊在额顶缝处汇合，汇合处超过鳞骨颧突基部的前缘。矢状脊发达，项脊与枕外脊非常发育，枕外脊与矢状脊夹角小于 90°，枕外隆突粗壮。在枕外脊两侧的凹面上有粗糙的肌肉附着痕迹。髁孔位于枕髁基部内侧。

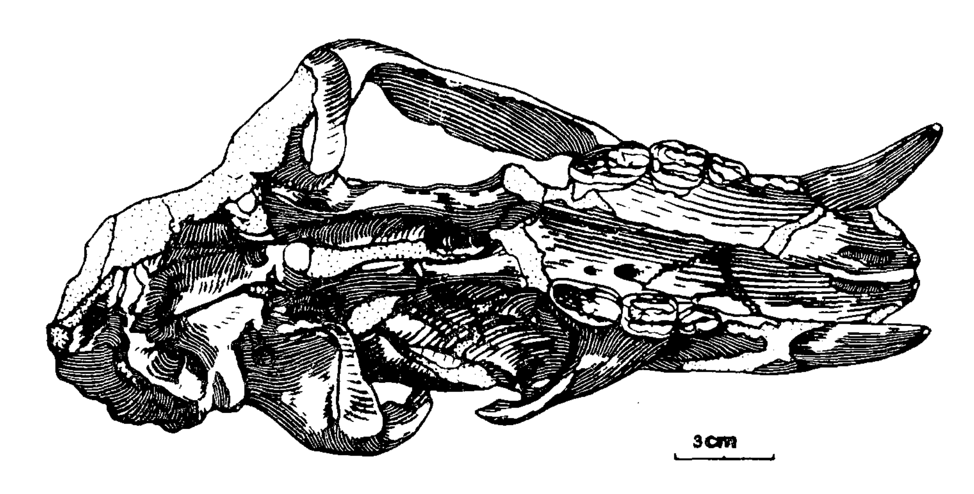


图 1　沂南熊(新种)头骨腹面视，正模 V10320

Fig. 1　*Ursus yinanensis* sp. nov. skull, ventral view, Holotype V10320

颧弓长度大于 P1 到 M2 的距离，眶下孔侧扁，位于 M1 前尖上方。上颌骨颧突基部前缘起始于 M1 前尖处，后缘止于 M2 中间，下缘在 M2 上方约 8mm。腹视，犬齿

1）大写字母代表上牙，小写字母代表下牙。

前内方有一对门齿孔。颌腭缝最前端与 P4 内尖的位置相当,向后延伸至 M2 前缘。颌腭缝后有两对腭前孔。硬腭在中间部位略凹陷,其宽度前后基本一致,近 36mm。硬腭后缘前距 M2 末端约 10mm, 后距关节窝约 52mm。 腭骨翼突长度与翼骨长度接近。翼骨相对较长,延伸至鼓室前方。翼骨与腭骨的骨缝远在翼管前开口的前方。翼管长约 13 mm, 其后开口与外侧的颧突关节窝正对。翼管末端接卵圆孔。在关节窝的后壁基部有一关节后孔。关节后突向后延伸, 其锐脊状外缘与乳突相连。外耳道在关节后突与乳突之间的凹槽内,十分靠近乳突;鼓室扁平, 纵向较长。咽鼓管开口位于鼓室前内侧。外耳道与鼓室部分区分很明显并基本垂直于鼓室长轴方向,长度与鼓室者一致,未超出关节后突后外缘。乳突较发达,副枕突位于乳突与鼓室后侧,但更靠近前者, 与鼓室仅在基部相连,虽局部破损,但仍可看出比乳突小。鼓室、乳突及副枕突中间围成一个凹陷,中间有茎乳孔, 并由乳突上的一条脊分为两部分。颈动脉孔和后破裂孔位于鼓室后缘与基枕骨交界处。

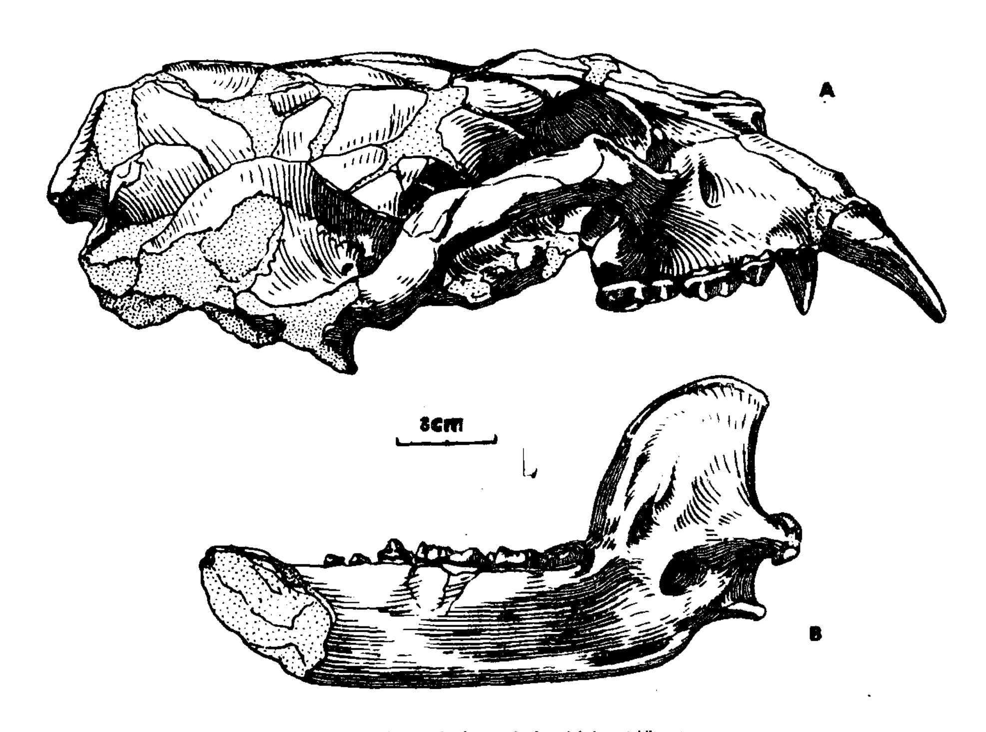


图 2 沂南熊(新种)头骨及右下颌,正模 V10320

Fig. 2 *Ursus yinanensis* sp. nov. skull and right mandible, Holotype V10320
A 头骨右侧视, skull, lateral view; B 右下颌舌面视, right mandible, lingual view

上齿列(图 3,A):I1 与 I2 的齿槽孔大小接近。I3 齿槽孔最大, 与犬齿齿槽孔相接。当上下颌咬合时,下犬齿伸到 I3 和上犬齿之间的空隙中。犬齿粗壮,齿尖锐利,由齿尖到齿冠基部迅速变粗大,齿根侧扁。从齿尖伸至齿冠基部有二条纵脊,分别位于前内侧和后侧,后者更显发达,其内侧有一与之平行的凹槽。牙齿前内侧靠近齿冠基部有一与下犬齿咬合形成的长条形磨蚀面,延伸到齿冠中部。P1—3 的齿槽孔很小,前后排列紧密。

P4 呈三角形，由前尖、后附尖、原尖三部分组成。前尖最粗大，占牙齿全长 2/3 多，锥状，是颊齿中齿尖最高的。前脊钝，后脊锐并直接连向后附尖。前尖的后内侧面平坦，与后附尖内面组成一平整切割面。后附尖矮小，磨蚀后成低平脊状，侧扁，内平外凸，分隔前尖和后附尖的沟在外侧深且长，内侧仅靠上部有一点痕迹，因此裂叶构造不典型。原尖最低小，呈圆钝突起，位于切割面之下正对着裂沟的内侧位置。齿带在四周均较发育。

M1 呈矩形，前后伸长。前缘略凹，后缘略凸，内外壁基本平直，但在牙齿中央略有收缩。前、后尖呈较高的锥状，后尖比前尖略小，二尖都有前后齿脊。没有前、后附尖。后尖后脊歪向牙齿后外角。在前尖、后尖外侧面，自齿尖到齿带处发育一些规则的细纹。前、后尖占牙齿宽度的近 1/2。原尖和次尖磨蚀成一条连通的凹槽。齿带仅在牙齿外、前、内侧

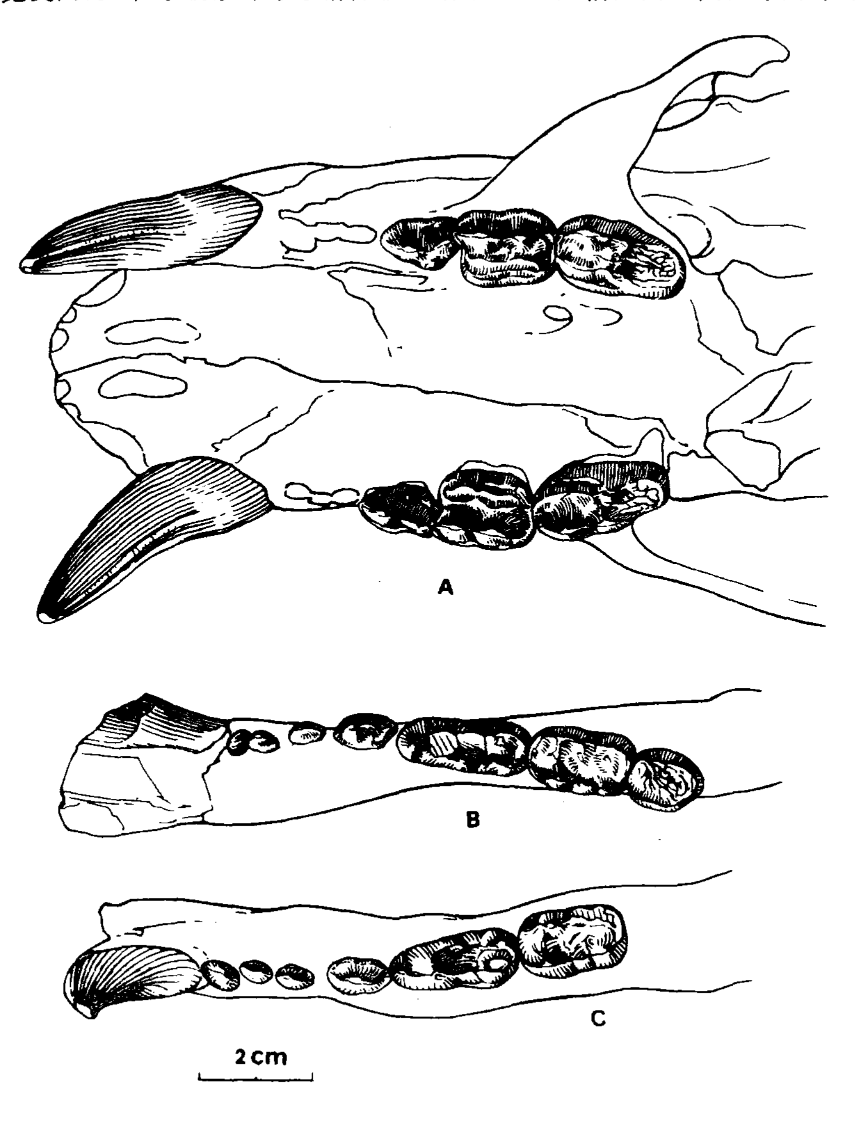


图 3　沂南熊(新种)上下齿列，冠面视，正模 V10320

fig. 3 *Ursus yinanensis* sp. nov. upper and lower teeth, occlusal view, Holotype A. 上齿列 upper teeth; B. 右下齿列 right lower teeth; C. 左下齿列 left lower teeth

发育。后尖后脊与次尖之间围成一扇形磨蚀面，上有简单的褶皱，其余嚼面较光滑。

M2 显著延长，跟座发达并向后收缩。前尖、后尖占齿宽的 1/3，形态与 M1 者相似，但更低小。齿脊仍很清楚。原尖为一低长的隆脊，次尖仅微弱发育。从前尖上发出的一些细弱的褶纹伸至凹陷的嚼面中央，同时在前、后尖外侧面自齿尖到齿带发育一些规则的垂直细纹。外侧齿带隐约可见，终止于跟座前端；内侧齿带发育，向后终止于跟座前缘，向前逐渐消失。跟座长占齿长约 1/2，向后收缩。跟座表面布满条形褶皱，向前延伸至后尖与次尖之间。由于 M2 跟座与 m3 组成一对咬合面，所以两者的发育状况是相互对应的，表现在 M2 跟座的大小、形态、冠面纹饰发育情况与 m3 者非常相似；M2 跟座嚼面转向外上方同样与 m3 着生位置靠上，嚼面转向内上方相适应。

下颌(图 2,B; 图版 II):下颌全长(在关节突处)为 180mm。下颌水平支高度由前向后略有减小，在p3 处高为 38mm。水平支下缘基本平直。下颌联合部长，后端伸达 p2 正下方，联合部外缘与水平支长轴夹角大于 45°。有两个颏孔，分别位于 p3 和 m1 三角座下方。下颌上升支前缘与水平支夹角略小于 90°，后缘垂直于水平支长轴，整个上升支向上收缩缓慢，因此冠状突较宽大。关节突宽圆，与齿列嚼面高度一致。角突较发达，位置相当于水平支高度的 1/2，向后延伸并略超出关节突。在右下颌上有一明显次角突，左下颌这一特征不明显。咬肌窝深，表面有很多突起和短嵴，供强健的咬肌附着。下颌内面有一大而圆的下颌孔，位于 m3 与关节突中间偏下方。

下齿列(图 3,B,C): 下犬齿扁长锐利，齿冠基部及齿根横切面为椭圆形，在前内侧和后侧各有一条齿脊，从齿尖一直伸向齿冠基部，前者更发达些，其基部向后有齿带，在牙齿后缘消失。在牙齿后外侧靠近齿尖有一长条形磨蚀面，延伸到齿冠中部。从 p1 到m3 整个齿列呈弧形向外弯曲。 m1 到 m3 齿列纵轴与水平支长轴夹角为 18°。p1—p3 很小、单根，低冠，冠面都呈椭圆状，p1 略大，紧靠犬齿，并略有偏转，p2 和 p3 等大。p2 与 p3、p3 与 p4 之间有齿隙。

p4 侧扁，仅有一高大的主尖，主尖后脊比前脊锐利，齿带在四周非常发育，并在牙齿后端抬升形成一小尖。在内齿带靠近牙齿后端约 1/3 处有一小尖，由此尖发出二条短脊，一条伸向主尖，另一条伸到主尖后脊。

m1 前窄后宽。三角座比跟座略长，但高度基本一致，二者之间由一宽谷分开。在谷底隐约可见二条近似平行的弱脊，一条从下后尖至下内尖，另一条从下原尖到下次尖。下前尖位于牙齿前端正中，为低小的钝锥状，与下原尖前脊组成弱的裂叶构造，在其外侧面可见一平整的切割小面，它与 P4 的切割面对应。下原尖是 m1 各尖中最粗大的，牙尖偏向牙齿外缘，前脊沿外缘连向下前尖的基部外侧，自下原尖向内侧发出一脊连到下后尖基部。下后尖小，位于下原尖后内侧，比下前尖低，但自外侧能见到。下后尖之前没有附尖，因此三角座向舌侧开放。跟座由并列的二个尖组成并靠近跟座后缘，下次尖较大，但磨蚀得比下内尖低，下内尖低于下后尖。跟座后缘有一条很弱的环状脊。咀嚼面光滑。在齿冠的外侧面，从齿尖垂直向下发出很多规则的细纹。牙齿齿带仅发育在跟座外侧。

m2 呈较规则的矩形。内侧齿尖比外侧者高。下原尖为低的隆起，与锥形的下后尖相对，下后尖前后各有一小尖。下原尖与下后尖之间由一弱脊相连，使三角座与跟座隔开，前者占牙齿的 1/3。下次尖为跟座中最大的一个尖，磨蚀得很低，它与下原尖以一细

沟分开。下次尖之后隐约可见一小尖。在下内尖的相应位置上开始分化为二个等大的小尖。三角座和跟座表面较光滑，在跟座前部，从下原尖发出一条脊伸向跟座嚼面中央，釉质已磨蚀掉。牙齿外侧面有均匀分布的垂直细纹，无齿带。

m3 短圆，前缘平。冠面无显著齿尖，只在前外角有一略高的隆起，自上向冠面发出数条褶皱。牙齿冠面四周隆起形成一环状脊，中间的咀嚼面略下凹。无齿带。从外侧看，m3 没有被下颌上升支挡住。它的着生位置靠上而不同于前面的牙齿，冠面向外上方偏转。

二、比较讨论

在所有熊科动物中，*Ursus* 是完全适应杂食性生活的类群，因而对环境的适应能力极强，这是它能够成功地繁衍至今的原因之一。在它的进化过程中，随着对杂食性适应的不断完善，它的前臼齿逐渐退化，数目减少；裂齿退化，逐步失去剪切功能；而主要用于研磨的臼齿却不断增大其咀嚼面积，并且出现趋于复杂化的褶皱和瘤饰；齿尖多分化。因此，*Ursus* 很容易同其他熊类分开。本属主要有以下特征：1）前臼齿相对臼齿很小，并趋于退化，p2、p3 和 P2、P3 都是单根。2）P4 双根，原尖位于裂凹内侧。3）M1 前内角近于直角，唇侧齿带弱，也不贯穿全齿，唇侧无明显中凹。4）m1 三角座低，裂叶构造退化，三角座与跟座之间由宽的谷分开。齿带退化。沂南标本与 *Ursus* 的上述特征完全一致，归入该属似无疑问。另外，它自身的很多性状，如体型小，前臼齿数目全，下裂齿的下后尖之前没有附尖，臼齿齿尖及冠面齿饰结构的简化，说明了它与 *Ursus* 这一属上新世的原始类型很接近。

上新世 *Ursus* 大多发现于欧洲，而国内这方面研究程度较低，目前仅报道过三种：*Ursus* sp., *U. sinomalayanus*, *U.* cf. *etruscus*。其中后两种时代偏晚，与沂南标本在形态特征上差别较大。1940 年德日进简述了一段发现于山西榆社麻则沟的下颌，将其定为 *Ursus* sp.。他当时未作仔细研究。从所附插图看，它与欧洲的 *Ursus minimus* 很相似，与沂南标本的区别是，其 m1 的下后尖之前已有一附尖，因而代表了这一支系中较进步的类型。

欧洲上新世的 *Ursus* 主要有以下各种：*Ursus boeckhi* （=*U. wenzensis*）（MN 15），*Ursus ruscinensis* （MN15），*Ursus minimus*（=*U. arvernensis*）（MN 16b），*Ursus etruscus* （MN 17—18）。沂南标本与 *Ursus etruscus* 差别较大，两者属于不同的进化支系。形态上与沂南标本相似的只有前三种。

1. 与 *Ursus boeckhi* 对比

U. boeckhi 是目前发现的 *Ursus* 属中时代最早、结构相当原始的种，最初是由 Schlosser（1899）根据匈牙利 Baroth-köpecz地点的材料确立的。根据他的记述，化石产自一套出露广泛的褐煤层，包括他认为是同一个体的两枚下犬齿，一右 p4，完整的左侧 m1、m2、m3 各一枚及破损的右 m1、m2、m3 各一枚。Frick（1926）在讨论早期熊类系统关系时首次提到模式种的下颌特征（有前咬肌窝）。1929 年匈牙利的古生物学家 Mayer von Mayerfels 首次记录了在 Baroth-köpecz 褐煤层中 *U. boeckhi* 的一段带有

I1—M2 的左上颌，但遗憾的是他没作任何系统描述和测量，只附有一个没有比例的放大图版。直到 1947 年 Thenius 才首次对这段上颌进行详细描述和讨论。这样在模式种地点，*U. boeckhi* 就包括了这三批材料。如果它们确实属于同一种的话，那么与沂南标本相比，它们有以下相同点：1）个体小。2）犬齿侧扁，前后的直径远远大于侧向直径。3）裂齿仍处于 *Ursus* 支系中进化水平很原始的阶段，即仍不同程度地保存有裂叶构造，m1 下后尖之前没有附尖。三角座与跟座之间由一宽谷分开。4）前臼齿数目全。5）臼齿咀嚼面积没有显著扩大，冠面齿饰尚未出现复杂的褶皱和瘤状突起。m2 和 m3 相对 m1 短小。但沂南标本与 *U. boeckhi* 有以下不同：1）*U. boeckhi* 的 P4 相对 M1 和 M2 仍较大，裂叶构造明显，后附尖高，裂凹深。M1 接近正方形，内齿带甚发育并在次尖处膨大，这是更古老的熊类如祖熊 *Ursavus* 具有的特征。M2 内齿带延伸至跟座内侧。沂南标本 P4 相对臼齿较小，裂叶构造退化，后附尖低平，裂凹很浅。M1 沿齿列长轴方向伸长，内齿带发育较弱，在次尖处不膨大。M2 内齿带止于跟座前缘。跟座也比 *U. boeckhi* 者发育。2）*U. boeckhi* 的下颌有前咬肌窝，只有在中新世更古老的熊类中才有此特征。下犬齿有三条齿脊。m1 三角座占牙齿比例比跟座大，并非常高大。脊状的下前尖较高，它与下原尖前脊组成明显裂叶，呈不对称 V 字形。下原尖靠近牙齿中央。跟座上的两个尖离牙齿后缘较远。沂南标本下颌无前咬肌窝，下犬齿有两条齿脊，m1 三角座比例小，三角座各牙尖相对较低。下前尖已收缩成低锥状，裂叶退化，下原尖已移向牙齿外缘。下前尖、下后尖和下内尖高度上依次降低。跟座上的两个尖紧靠牙齿后缘。*U. boeckhi* m2 无下前尖，跟座上的下内尖和下次尖各自分化为两个小尖。沂南标本 m2 有下前尖，且 m2 和 m3 宽度相对 m1 的比例比 *U. boeckhi* 大；齿带更加退化。由上看出，沂南标本与 *U. boeckhi* 相比有一定差别，沂南标本更趋进步。

归入到 *U. boeckhi* 中的还有欧洲其他地点的一些熊类化石，其中包括 1953 年 Stach 根据波兰 Węże (MN15) 材料建立的 *Ursus wenzensis*，(Thenius 1958) 以及法国 Roussillon 盆地(在 Perpignan 附近)的一类小体型熊材料 (Depéret, 1892)。它们虽然在大小和形态特征上与匈牙利 Baroth-Köpecz 者略有差异，但基本特征稳定，与沂南标本还是有明显的差别。

2. 与 *Ursus ruscinensis* 对比

Ursus ruscinensis Deperet 是早期熊类中引起争议颇多的一个种，主要在于其个体之大，结构之特殊在早期熊类中是很少见的，目前仅发现于 Roussillon 盆地。最初 Depéret (1890) 根据一个完整的下颌建立一亚种，*Helarctos arvernensis ruscinensis* Deperet。这是体型较大的一种熊。1892 年他又研究了同一地点产出的一小型熊类头骨及下颌，并订一亚种 *Helarctos arvernensis pyrenaicus* Deperet。Depéret 以后再也没有使用这个名称，而只用 *Ursus* (*Helarctos*) *arvernensis ruscinensis* Dep. 统称这两类熊。他认为这两类熊是 *Ursus* (*Helarctos*) *arvernensis* 的比较原始的类型，大小不同是由于雌雄差异。在此之后一直没人对这些材料的分类地位予以充分讨论，包括 Schlosser 在 1899 年确立 *U. boeckhi* 时，也忽略了对法国这批材料进行详细的对比，而把它们一并归入欧亚大陆维拉方期常见的一类熊 *U. etruscus* 中。直到 1947 年 Thenius 对法国这批材料进行了重新研究，他注意到这两种熊在大小和牙齿结构上是完全不同的，并把体

表 1 ***Ursus yinanensis* sp. nov.** **牙齿测量及与有关种对比**（单位：毫米）(长/宽/高)

Table 1 Measurements of the teeth of *Ursus yinanensis* sp. nov. and comparison with the related species (in mm) (L/W/H)

	Ursus yinanensis sp. nov.	*Ursus boeckhi* Schlosser (=*Ursus wenzensis* Stach)					*Ursus ruscinensis* Depéret, 1890[2]	*Ursus minimus*[5]	*Ursus* sp. Teilhard de Chardin, 1940
		Schlosser, 1899	Maier von Mayerfels, 1929[4]	Depéret, 1892[1]	Viret, 1954[3]	Stach, 1954			
Upper Canine	20×12×27			20.5×15.5×?					
P4	13.6×8.8			14×?	14.8×9.6	13.3×9		18×?	
M1	18.1×13.6			17×?	20×14.6	17.6×12.9		23×?	
M2	23.5×13.2			22×?	25×15	22.5×13.9		27×?	
L:P4/M1	0.75		0.83	0.82	0.74	0.76		0.78	
L:P4/(M1 + M2)	0.33		0.37	0.36	0.33	0.33		0.36	
M1(L)/M1(W)	1.33		1.15		1.37	1.36			
L:M2/M1	1.30		1.24	1.30	1.25	1.28		1.17	
Lower Canine	22×12×25	21.5×12.5×26		22×?×29			±27×? ×±36	19.1×12.4	
p1	7.1×4.9								
p2	5.6×4.0						6×4.5		
p3	6.0×4.2			6.5×4.5	6.4×3.9		5×4		
p4	11.0×6.4	? ×5.5		10×6	12.5×6.8		12.5×8	13.1×7.5	
m1	20.6×9.5	20.5×10		22.5×9	20.9×8.9		24×12.5	24×12.3	24×11
m2	18.1×11.4	18×11		20×10.5	20.4×11.9		22×14	21.3—22.4×13.0—14.5	20.5×13
m3	12.1×10.8	14×10.8		14.5×11	15×12.5	17.7×13.3	18.5×13	15.2—16.5×12.4—13.5	16×14.5
L:m1/m2	1.14	1.14		1.20	1.02		1.09	1.07—1.13	1.20
W:m2/m1	1.20	1.10		1.19	1.34		1.07	1.06—1.18	1.18
L:m1/(m2 + m3)	0.68	0.64		0.68	0.59		0.59	0.62—0.66	0.66

1), 2) after Erdbrink (1953).
3), 4) measured from the sketch and plate.
5) upper teeth from type specimen (Erdbrink, 1953); lower teeth after Heller (1949).

型大的熊沿用 Depéret 原来的含义提升为一独立的种 *U. ruscinensis* Deperet, 小体型的熊因为与 *Ursus boeckhi* 形态特征完全一致而被归入后者 (Thenius, 1947, 1958)。

沂南标本与 *U. ruscinensis* 相比个体要小得多。*U. ruscinensis* 的下颌异常粗壮，下颌联合部外缘近于垂直，水平支下缘向后平伸至异常发达的角突下缘。这些特征不仅在沂南标本上不具备，而且在其他 *Ursus* 中也是罕见的。从牙齿结构看，*U. ruscinensis* 犬齿非常粗壮强大，p4 到 m2 齿冠高大，齿尖锐利，尤其是下裂齿更为独特：没有任何次生小尖，在本属中齿尖结构达到最大简化。下原尖高大，占三角座的绝大部分，齿尖位于牙齿中央；下前尖尖锐，与下原尖前脊构成发达的裂叶；下后尖很低小，自外侧看不到。跟座与三角座之间由V字形谷分开；跟座上两个尖都靠近跟座的前缘。下次尖高度与下前尖相同，自外侧看不到下内尖。整个牙齿外侧有齿带，后面的更发达。它的 m2 虽然已出现齿尖分化，但四个主要齿尖依然高大并占主导地位。其 m3 冠面上没有明显的齿尖。所有这些特征与沂南标本和其他 *Ursus* 成员大不相同，而且反映出这类熊仍以肉食性为主，但已开始向杂食性方向发展。

3. 与 *Ursus minimus* 对比

1827 年 Devèze 和 Bouillet 根据法国 Perrier 的一个头骨确立此种，而次年 Croizet 和 Jobert 据此地点的另一头骨命名的 *U. arvernensis* 实质上是前者的同名。与沂南标本相比，它已显得相当进步。它个体较大，m1 下后尖之前已出现附尖；臼齿已显著扩大，适应杂食性的齿饰、齿尖结构更加复杂，与沂南标本差别显著。

鉴于以上对比，本文将沂南标本定一新种：*Ursus yinanensis*。新种一方面保持了一些原始性状，如个体小，犬齿侧扁，前臼齿数目全，下裂齿下后尖之前没出现附尖，m1 长度比 m2 和 m3 大很多等；另一方面，其自身已具有很多进步性特征，如 P4 相对后面的臼齿有些退化，M1 拉长，M2 跟座已比较发达。m1 下前尖为低锥状，下原尖偏向牙齿外缘，跟座上的两个尖已移向牙齿后缘。上、下臼齿的齿带退化等。

1945 年，Kretzoi 建立一个新属 *Protarctos*，并指定 *U. boeckhi* 为它的属型种。该属有以下特征：体型小，P4 较大，前臼齿数目完整，m1 下后尖构造简单，且下后尖与下内尖之间有宽的谷。Thenius (1958) 认为把它降为亚属更合适。本文同意这种观点，沂南标本除了 P4 略小以外，其他特征都符合上述亚属的定义，故将之归入该亚属。

关于新种的时代可以从以下几方面判断。*Ursus yinanensis* sp. nov. 比山西榆社麻则沟的 *Ursus* sp. 原始，根据对榆社盆地研究的最新资料，后者的时代大约为距今 3m.y.。从演化水平看，*Ursus yinanensis* sp. nov. 介于 *Ursus boeckhi* 与 *U. minimus* 之间，但更接近前者。根据现有资料，*Ursus boeckhi* 可能出现于 MN14，最晚到 MN15，相当于我国榆社期高庄地方动物群；*Ursus minimus* 只出现于 MN16b，与榆社期麻则沟地方动物群时代相当，因此，*Ursus yinanensis* sp. nov. 时代应相当于 MN16a 或稍早。从与沂南标本伴生的动物化石来看，郑绍华(1984)根据仓鼠类 *Kowalskia yinanensis* 的演化水平认为含化石地层时代可能为 MN15，这也与本文的结论基本一致。

三、早期 *Ursus* 的系统演化

法国 Roussillon 盆地的熊类材料发表之后（Depéret，1890，1892），并没有引起学术界足够重视，人们只是把它们作为 *Ursus arvernensis* 的比较原始的类型，或者将其归入 *Ursus etruscus*（Ristori，1897；Schlosser，1899），但 *U. etruscus* 和 *U. arvernensis* 显然都代表了欧洲维拉方期较进步的属种。虽然也有一部分学者（Reichenau，1906；Mottl，1934；Kretzoi，1938；Heller，1939）主张将 Roussillon 的熊类从上述两种中分出，单独称为 *U. ruscinensis*，但很少有人把它与 *U. boeckhi* 直接联系起来。直到 1947 年，Thenius 对 Roussillon 熊类的性质进行重新评价之后，围绕它们的分类位置及起源、演化问题在学术界又展开了激烈的讨论。Viret（1954）注意到，Roussillon 的这两类熊的大小差异和牙齿的区别已超出他所观察到的雌雄差异的正常范围，但他仍主张 Roussillon 的熊类材料代表一个种，即 *Ursus ruscinensis*，它与匈牙利的 *U. boeckhi* 特征基本一致，并享有命名上的优先。他把自己描述过的一个发现于 Perpignan 的熊类头骨及右下颌连同 Stach 1953 年建立的 *U. wenzensis* 都归入 *U. ruscinensis*。Thenius 认为 Roussillon 的熊类代表两个独立的种，而不是同一种的雌雄变异，*U. ruscinensis* 的含义仅限于 Depéret（1890）定义的较大的熊类。小个体的种应归入 *U. boeckhi*。Erdbrink（1953）虽然同意 Thenius 的划分，但他却认为小体型的熊与 *U. minimus* 相似应被归入后者；他把 *U. boeckhi* 看作是 *U. ruscinensis* 和 *U. minimus* 的共同祖先，理由是 *U. boeckhi* 兼有后两种的特征，且时代上比后两者早。但在笔者看来，首先，将 Roussillon 的小体型熊归入 *Ursus minimus* 不合适，因为后者已相当进步，m1 下后尖之前已出现附尖，裂齿功能已向杂食性转变，臼齿的咀嚼面积已显著扩大，齿饰更复杂。其次，*Ursus ruscinensis* 不仅在大小上，而且在牙齿结构上与 *U. boeckhi* 区别较大。虽然它们有一些早期熊类的共有特征，如裂齿有较发达的裂叶，m1 相对后面的臼齿较长，下后尖之前没有附尖，臼齿齿带较发育等，但 *Ursus ruscinensis* 个体异常粗壮，下颌形态独特（近于垂直的联合部外缘和有发达的位置很低的角突），臼齿高冠，冠面齿尖、齿饰结构最简化，m1 三角座与跟座之间由 V 字形谷分开，这些特征似乎更接近其食肉类的祖先。*Ursus boeckhi* 反倒接近后期典型杂食性的熊类，表现在角突变小，位置升高，与下颌下缘不在同一直线上。牙齿齿冠低，齿尖齿饰增多，m1 三角座与跟座之间由 U 形谷分开。这表明 *U. ruscinensis* 和 *U. boeckhi* 可能起源于不同的祖先，并代表向不同方向进化的两个支系，现生分布于北半球的 *Ursus* 最主要的两大类群棕熊和黑熊，很可能就由这两个支系各自演化而来，其中 *U. ruscinensis* 与 *U. etruscus* 和现代棕熊关系更密切，而 *U. boeckhi* 是 *U. yinanensis* sp. nov.、*U. minimus* 和现代黑熊的最早祖先。这样看来，在早上新世末到中上新世早期这段时间里，*U. boeckhi* 和 *U. yinanensis* sp. nov. 这一支系的早期分子就已扩散到整个欧亚大陆了。

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ON A NEW SPECIES OF PLIOCENE *URSUS* (CARNIVORA: URSIDAE) FROM YINAN, SHANDONG PROVINCE

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Key words Yinan, Shandong; Pliocene; *Ursus*

Summary

The present paper deals with a new species of Pliocene *Ursus,* on the basis of one skull with two associated mandibles and a single right ml[1]. The new materials, excavated from the reddish brown breccia of a cave deposit in Yinan, Shandong, with a maximum thickness of 4.2m, turn out to represent the first reliable record of middle Pliocene *Ursus* ever found in China.

Family Ursidae Gray, 1825

Genus *Ursus* Linnaeus, 1758

Ursus (*Protarctos*) *yinanensis* sp. nov.

(Pl. I, II; figs. 1—3)

Holotype IVPP: V10320, a skull, late ally compressed, containing C and P4-M2 of both sides; left part of occipital region and tympanic bulla lacking; the middle part of zygomatic arches damaged. Left mandible with c-m . Right mandible with p2-m3, ml and lower canine damaged, angular process broken.

Type locality Western Hills of Shuangquan, Yinan, Shandong.

Referred specimen V10321, a single right ml, paraconid lost.

Derivation nominis After the name of Yinan County.

Horizon Reddish brown breccia.

Geological Age Probably middle pliocene, equivalent to MN16a.

Diagnosis *Ursus* of small size, with short snout. Tympanic bulla flat. The angle of anterior border of symphasis and horizontal axi of ramus is more than 45°. The antero-posterior diameter of canine is much larger than the transverse one. Premolars complete. Carnassial blades reduced. Proportionately short P4 relative to Ml and M2. Ml lacks parastyle and metastyle. The talon of M2 enlarged, nearly half of the tooth length, with moderately developed wrinkles on the mastication surface. The trigonid of ml is low, consisting of protoconid on labial side of the tooth, single undivided metaconid, and cone-like paraconid. m2 and m3 are relatively short.

Description

SKULL: The animal is in adult state since it shows partially fused sutures and developed sagittal crest on the skull, with moderately worn teeth.

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1) Majuscule letters for upper teeth, minuscule for lower teeth.

The skull is small- sized and elongate, with a short and narrow snout. The entire length of the skull is approximately 280mm. The length of nasal is 62 mm. The frontal crests are clear and join backward forming a strong sagittal crest. The joint point exceeds the superior lip of mandibular fossa.

The zygomatic arch span is much longer than the length from P1-M2. The infraorbital foramen is situated above the paracone of M1. The anterior rim of the implantation of the zygomatic arch is situated at the paracone of M1, posterior rim, at the midpoint of M2.

On the ventral surface of the skull, a pair of incisive foramina are present at the inner side of canines; two palatine foramina on each side, all behind the maxilla-palatine suture, larger one in front. The breadth of palatine is 36mm, the hinder end of which is about 10mm from M2. There is a shallow depression in the center of palatine. The maxilla-palatine suture starts at the level of paracone of P4, ends at the hinder border of M1. Pterygoid reaches the front edge of the bulla, the length of alisphenoid canal is 13mm. Its posterior foramen is opposite the mandibular fossa. In the squamosal behind the postglenoid process, there is a postglenoid foramen, which is not on contact with the bulla, and far from the external auditory meatus. The tympanic bulla is flat and anterior-posteriorly extended. Its longitudinal axis is parallel to that of the skull. The well discernible external auditory meatus is long, nearly perpendicular to the bulla and directly lying in front of moderately developed mastoid process. Stylomastoid foramen, divided in two parts by a crest on the mastoid process is situated, in the depression formed by the paroccipital process, mastoid process and posterior border of the bulla.

UPPER TEETH: Upper canine very trenchant, with the anteroposterior diameter of the crown considerably larger than the transverse one. There are two ridges running from the top of the crown to the base, the antero-inner one and posterior one. An attrition plane is present through biting with lower canine at the antero-inner side near the base of the crown.

P1-P3 are indicated by alveoli, crowded and single-rooted.

P4 of triangular form, consisting of three main cusps, of which the paracone is the heaviest and highest, occupying nearly 2/3 of the tooth's length. The posterior ridge of paracone is sharper but shorter than the anterior one and stretches directly to the top of the metastyle. The metastyle is moderately worn to the low level, inwardly flat-sided and outwardly curved. The paracone and metastyle form the less developed carnassial blades (versus shear-like in early *Ursus* representatives). The protocone is the smallest, opposite the shallow carnassial notch. The whole tooth is surrounded by the cingulum.

M1 rectangular-shaped, anterior edge concave and posterior one convex somewhat, basically flat borders both of inner and external, with a slight constriction medianly. The paracone and metacone are cone-like and occupy nearly 1/2 of the tooth's breadth, both bearing marked anterior and posterior ridges. No trace of parastyle and metastyle is present. The protocone and hypocone are deeply worn to form a merged groove (as commonly seen in the black bears of today). The cingulum is developed labially, lingually and anteriorly. In between hypocone and the posterior ridge, directed postero-externally, of the metacone, lies a backward-widening slope.

M2 much wider anteriorly than posteriorly, inner border tending flat. Paracone and metacone remain the same as in M1 but much lower. Protocone is of elongate wedge-like form, even lower than outer cusps, and hypocone is barely discernible. Labial cingulum is much light, ending before the talon; lingual cingulum is well-developed and stopped by the talon and

vanishing as far forward to the anterior border of the tooth. Talon occupies 1/2 of the length of the tooth, and constricts sharply backwards, the occlusal surface being moderately corrugated, enclosed by a circular crest instead of accessory tubercles.

MANDIBLE: The entire length is 180 mm (at the condyle). The depth of horizontal ramus is slightly larger anteriorly than posteriorly, 38 mm at p3, with a flat inferior border. The symphasis is long, extending to below the p2. It is interesting to note that the construction of symphasis and lower canine, correlated with the development of the ramus, might suggest the adaptation of the animal to the mode of preying. In primitive bear, as in *U. ruscinensis,* the anterior border of symphasis streches almost vertically downward, immediately reaching the inferior border of the ramus, corresponding to the short snout, persistent depth of the ramus, robust canine of flat form, directed strongly posterodorsally, and anterior-posterior extended diameter of the canine. In progressive forms, with the lengthened snout (exclusive of *Helarctos*) and reduced-tending premolars, the anterior border of symphasis extends inferoposteriorly in a low angle with the long axis of ramus, with canine directed dorsally. As for the present materials, tht angle of anterior border of symphasis and horizontal axis of ramus is more than 45°. The coronoid process is wide, not much constricted as in recent bears. The condylar process lies at the same level with the tooth row. The angular process is markedly developed. The masseteric fossa is deep, on which many pits are present, marking the strong attachment of the masseter. There is a digastric process in the right mandible, which is not evident as shown in left one. The mandibular foramen is large and rounded. On the external surface of ramus, two mental foramina are present below p3 and ml respectively.

LOWER TEETH: Lower canine trenchant and sharp, bearing two ridges, of anterior-inner side and posterior side, the former more marked, at the base of which developed a backwards-extending cingulum. An attrition facet at the postero-external side.

pl-p3 small-sized, single-rooted, and low-crowned, with diastema in between. pl in contact with canine.

p4 laterally flat, bearing one main cusp. Its posterior ridge is markedly developed than the anterior one. Cingulum surrounds the whole tooth and forms a cingulum cusplet at the posterior end of p4. An incipient cusplet is discernible at the lingual cingulum from which projects two short weak ridges.

ml of torpedo-like, talonid swollen slightly. Trigonid is not much higher than talonid, and both are separated by a wide U-formed valley, at the bottom of which, two weak parallel ridges are discernible running from metaconid to endoconid and from protoconid to hypoconid respectively. The paraconid lies in front of the tooth, low and cone-like, and forms the rudimentary blades together with the anterior crest of the protoconid. A facet could be seen at the outer wall of this reduced shear. The protoconid is the heaviest, the cusp being situated at the labial side of the tooth. Its anterior ridge extends to the base of paraconid, posterior one directed postero-inwardly to the base of the metaconid. The metaconid is smaller and lower than paraconid, yet can be seen from labial side. There is no accessory cusplet between metaconid and paraconid, thus the trigonid is open to the lingual side. The two cusps of talonid situated toward the posterior border of the tooth. The hypoconid is heavier than endoconid, but worn to a lower level than the former. No accessory tubercles are present on the occlusal surface of talonid except for a weak enclosed enamel ridge at the end of the tooth. The cingulum is only developed at the outer wall of talonid.

m2 of rectangular form. All cusps lies on the inner and outer border of the tooth. Pro-

toconid is low and opposite metaconid, two being linked by a cross crest. Paraconid is anterior to the metaconid and an incipient cusplet is developed posterior to metaconid. Hypoconid is the heaviest cusp in talonid, posterior to which lies a discernible tubercle. Endoconid is divided into two subequal cusplets.

m3 short and half-rounded. The tooth bears no evident cusp except for a weak antero-external one. An enamel ridge encloses the occlusal surface, on which several ridge-like rugosities are present. The tooth is situated in base of ascending ramus, the crown being set at an angle to m2, and could be seen from labial side.

Comparison

The genus *Ursus* is easily distinguished frcm other Ursidae members in the following characters: 1) relatively small premolars tending reduced, P2, P3 and p2, p3 single-rooted; 2) P4 double-rooted, with a small protocone at the inner side, opposite the carnassial notch; 3) the antero-internal angle of M1 is sharp, almost 90°, labial cingulum weak; 4) the trigonid of m1 is low, carnassial blades reduced, presence of wide valley between talonid and trigonid.

Yinan specimen resembles *Ursus* in all these characters. On the other hand, It shows many features of its own, in its smaller size, flat canine, complete premolars, m1 bearing no accessory cusplet anterior to metaconid, simplified structure of cusps developmen and rudimentary wrinkles on occlusive surface of the molars, and less developed cingulum. The known species of *Ursus* which resemble Yinan-specimen are: *U. boeckhi*; *U. ruscinensis*; *U. minimus* from Europe, and *Ursus* sp. (Teilhard de Chardin, 1940), the only reliable fossil *Ursus* of Pliocene hitherto known in China.

1. Comparison with *U. boeckhi*

The species was first described by Schlosser(1899) on the basis of several lower teeth from Baroth-Köpecz, Hungary. Frick (1926) for the first time mentioned that there exists a premasseteric fossa on the lower jaw of the holotype of *U. boeckhi* from Baroth. Furthermore Maier von Mayerfels (1929) assigned a left maxilla bearing I1-M2 to *U. boeckhi*, also from the stated type locality. Unfortunately he didn't give any detailed description and measurements except for a magnified plate. The only description on the upper teeth is from Thenius in 1947. If all these materials belong to the same species, then it has the following features in common with Yinan specimen: 1) small-sized; 2) flat canine; 3) complete premolars; 4) trigonid and talonid of m1 separated by a wide valley with undivided metaconid; 5) mastication surface of the molars not so enlarged as that reached in recent bears; 6) proportionately short m2 and m3 relative to m1 with no complicated rugosities and tubercles on the mastication surface.

However, Yinan specimen differs from *U. boeckhi* remarkably in having a smaller P4 relative to the M1 and M2, more rectangular shape of M1, with less developed lingual cingulum on M1 and M2 than those of *U. boeckhi*. For the mandible, Yinan specimen lacks premasseteric fossa, which is, mentioned by Frick (1926), present in *U. boeckhi*. Also in the latter, the trigonid of m1 is higher and longer than its talonid, crest-like paraconid and sharp anterior crest of the medianly-situated protoconid form the prominent carnassial blades, and the two cusps of talonid are situated far from the posterior border of the tooth.

Apart from the material from type locality of *U. boeckhi*, the fossil remains of *Ursus* from certain localities of Europe have been referred to the species, inclusive of the assignment of *U. wenzensis* Stach, 1953 (MN15) from Węże, Poland, by Viret (1954) and Thenius(1958), and *Helarctos arvernensis pyrenaicus* Deperet, 1892 (MN15) from Roussillon, France, which

later proved by Thenius (1947) to be fully equi'alent to *U. boeckhi*. These referred materials. though varying in size and morphology to some degree from the Baroth's materials, are stable in their main characters, and are well distinguish d from Yinan specimen.

2. Comparison with *U. ruscinensis*

U. ruscinensis, erected by Depéret (1890) on a single mandible with dentition, is only known in type locality of Roussillon, from the samé level with "*Helarctos arvernensis pyrenainus*." It is strikingly large and contains an extraordinaily robust ramus, with more or less straight inferior border directly running poste iorly to the strong angular process. The anterior border of symphasis is, from labial view, nearly vertical. The canine is very strong. More distinct characteristic of this bear is its peculiar development of lower carnassial, which reaches the most simplified structure in *Ursus*. The trigonid is proportionately large and high, protocone occupying the major part of trigonid and situated medianly on the tooth; paraconid sharp and trenchant; metaconid is small and couldn't be seen from labial side. The trigonid and talonid of m1 are separated by a V-formed notch (versus U-formed valley in other ursids). Talonid consists of two cusps close to the base of trigonid. No sign of any cusplets can be seen. m2 shows omnivorous structure, but still remains high-crowned and the main cusps are prominent. All these features distinguish *U. ruscinensis* from Yinan specimen and other ursids. It seems that the animal more represent a carnivora-like form than a omnivorous one.

3. Comparison with *U. minimus* (=*U. arvernensis*)

The species are well studied, based on aburdant materialks mostly from Perrier, France. The Chinese material, briefly reported by Teilhard de Chardin (1940) as *Ursus* sp. on a lower jaw with dentition from Yushe, Shanxi Province, is similar in size and morphology to Perrier materials. Appearing first in early villafranchian, the species represents a morphologically progressive form of *Ursus* as compared to Yinan specimen, in its larger size, divided metaconid on m1, enlarged molars with more complicated rugosities on the mastication surface.

In a word, it is shown that Yinan specimen is distinct from any known species of *Ursus*. For it we erect a new one, *Ursus yinanensis*. The geological age of the new species may be judged in view of its evolutionary stage, which indicates a structurally transitional form between *U. boeckhi* and *U. minimus*. *U. boeckhi* may have occured early in MN14 and no later than MN15 of European Chronology. *U. minimus* is correlated with MN16b, equivalent to *Ursus* sp. (3 Ma.) from Mazegou lacal fauna of Yushean age in China according to sino-American joint research on Yushe basin. Thus *Ursus yinanensis* sp. nov. may represent middle pliocene age, probably equivalent to MN16a.

Phylogeny of early ursid

The well-known Roussillon bears were previously classified as one species under the genus *Ursus*, either to *U. arvernensis* by Depéret, or to *U. etruscus* by Ristori (1897) and Schlosser (1899), or finally to *U. ruscinensis* by Reichenau (1906), Mottl (1934), Kretzoi (1938), and Heller (1939). No one noted the direct relationship between *U. boeckhi* and Roussillon bears prior to 1947. Thenius (1947) restudied these materials and reached the conclusion that Roussillon bears represent two distinct species, rather than showing individual variation of the same species. *U. ruscinensis* should be retained for the large bear, and small one is in fully agreement with *U. boeckhi*. Viret (1954) noticed that the considerable difference of Roussillon bears exceeded the normal individual variation of the same kind. He qualifiedly regarded Roussillon bears as being one species of *U. ruscinensis*, which has *Nomenclatura Prioritas* to

U. boeckhi and *U. wenzensis*. Erdbrink (1953), while agreeing with Thenius on the presence of *U. ruscinensis*, argued that the small Roussillon bear should be placed in *U. minimus* on account of certain characters. He also considered *U. boeckhi* as a common ancestor of the Roussillon bears by reason of 1) perhaps the older age of *U. boeckhi*, and 2) the features of both Roussillon bears coexistent in *U. boeckhi*. It seems to the present author that *U. minimus* is morphologically progressive as compared to small Roussillon bear in its larger size, divided metaconid of m1 in particular, enlarged molars and more complicated rugosities on the mastication surface. In the case of large bear, *U. ruscinensis*, as Depéret correctly remarked, the teeth and mandible are constructed more after type of high Carnivora than any described species of *Ursus*. The vast difference between *U. ruscinensis* and *U. boeckhi* precludes the possibility of the derivation of *U. ruscinensis* from *U. boeckhi*. On the contrary, *U. boeckhi* is more similar to the typical true bear, thus intimating its derivation from a different ancestry. It is probable that *U. ruscinensis* and *U. boeckhi* may represent two evolutionary lineages, the former has close affinity with *U. etruscus*, and the latter is directly ancestral to *U. yinanensis* sp. nov. which distributed throughout Eurasian from early to middle Pliocene.

图 版 说 明

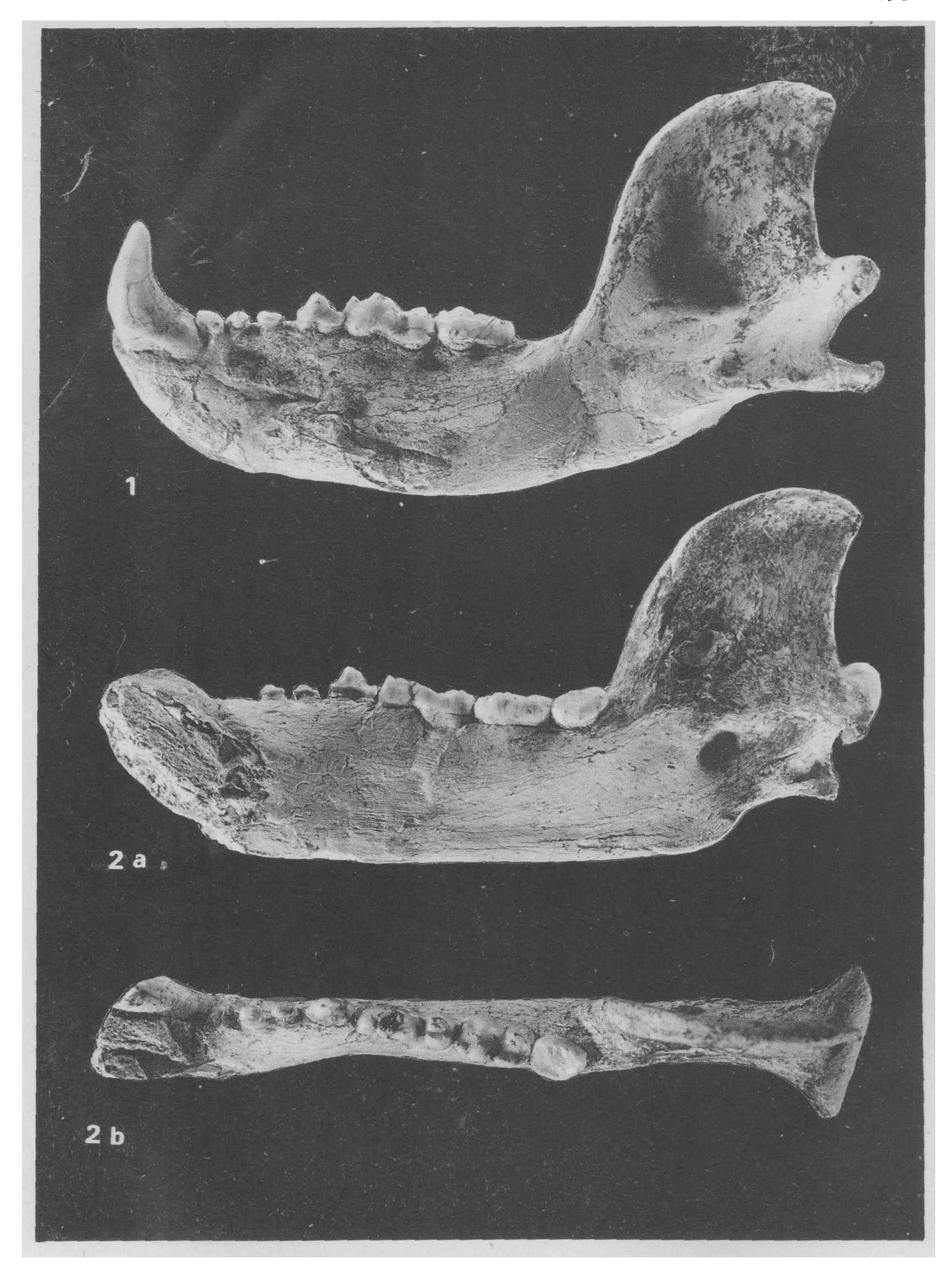
图 版 I

沂南熊(新种)头骨 The skull of *Ursus yinanensis* sp. nov., 正模 Holotype V 10320, ×3/5
1.右侧视 lateral view; 2.腹视 ventral view

图 版 II

沂南熊 (新种) 左、右下颌 Left and right mandible of *Ursus yinanensis* sp. nov., 正模 Holotype V 10320, ×2/3
1.左下颌,唇面视 left mandible, labial view;
2.右下颌 right mandible a. 舌面视 lingual view b. 冠面视 occlusal view


1
2


1
2a
2b